Index

Vol. 1 | 1957

IBM Journal of research and development

Editorial Staff

C. B. MacKenzie, *Editor*
H. B. Michaelson, *Associate Editor*
P. E. Magdeburger, *Associate Editor*
Will Burtin, *Graphics Consultant*
Nils Hansell, *Graphics Assistant*
M. T. Kucharik, *Production Manager*
Jane F. Murray, *Circulation Manager*

Advisory Board

W. W. McDowell, *Chairman*
J. W. Birkenstock
C. R. DeCarlo
C. C. Hurd
R. L. Palmer
E. R. Piore

Editorial Board

M. L. Lesser, *IBM Research Laboratory*, San Jose, California
A. Malmros, *IBM Airborne Computer Laboratory*, Owego, New York
R. E. Nienburg, *IBM Military Products Division* Kingston, New York
G. W. Petrie, *IBM Research Center* Yorktown, New York
P. J. Price, *Watson Research Laboratory*, New York City
F. J. Roehm, *IBM Product Development Laboratory*, Endicott, New York
A. P. Speiser, *IBM Research Laboratory*, Zurich, Switzerland
R. B. Stryker, *IBM Product Development Laboratory*, Poughkeepsie, New York
J. Taylor, *IBM Product Development Laboratory*, San Jose, California

The IBM Journal of Research and Development is regularly indexed and abstracted by Science Abstracts (I.E.E.—Britain), Chemical Abstracts, The Engineering Index, Physikalische Berichte, ASM Review of Metal Literature, Mathematical Reviews, Bulletin Signalétique (C.N.R.S.—France), Electronic Industries & Tele-Tech., Electronic & Radio Engineer, and Aviation Research & Development.

The IBM Journal of Research and Development is published quarterly in January, April, July and October by International Business Machines Corporation, 590 Madison Avenue, New York 22, N. Y. Officers: Thomas J. Watson, Jr., President; L. H. LaMotte, Executive Vice-President; Albert L. Williams, Executive Vice-President; Charles V. Boulton, Treasurer; Henry W. Trimble, Jr., Secretary. Subscriptions are accepted at $5.00 per year in the United States and North America, $8.00 per year in other countries.

List of issues in Volume 1

Number 1, January 1957 1-100
Number 2, April 1957 101-196
Number 3, July 1957 197-292
Number 4, October 1957 293-380

Address all inquiries to:
The Editor
IBM Journal of Research and Development
590 Madison Avenue,
New York 22, New York

Printed in U. S. A.

Table of Contents

January 1957 | Vol. 1, No. 1

- Articles

Domain Orientation in Barium Titanate Single Crystals
by D. P. Cameron 2-7

Design of Logic for Recognition of Printed Characters by Simulation
by E. C. Greanias, C. J. Hoppel, M. Kloomok, and J. S. Osborne 8-18

On the Theory of Relaxation Processes
by A. G. Redfield 19-31

A Three-Dimensional Printed Back Panel
by E. R. Wyma 32-38

Clarification of First-Order Semiconduction Effects through Use of Electrochemical Potentials
by J. A. Swanson 39-43

A Survey of Contact Resistance Theory for Nominally Clean Surfaces
by W. B. Ittner III and P. J. Magill 44-48

Development of the Electrostatic Clutch
by C. J. Fitch 49-56

An Analysis of Diffusion in Semiconductors
by S. Zaromb 57-61

The Random-Access Memory Accounting Machine —I. System Organization of the IBM 305
by M. L. Lesser and J. W. Haanstra 62-71

The Random-Access Memory Accounting Machine —II. The Magnetic-Disk, Random-Access Memory
by T. Noyes and W. E. Dickinson 72-75

Logical Design of the Digital Computer for the SAGE System
by M. M. Astrahan, B. Housman, J. F. Jacobs, R. P. Mayer, and W. H. Thomas . . . 76-83

Simple Constant-Temperature Oven and Control System
by G. R. Gunther-Mohr and S. Triebwasser 84-89

- Short Communications

Lattice Parameters of Zn_3As_2
by H. Cole, F. Chambers and H. Dunn 90-92

A General Theory of Multiple Spin Echoes
by J. W. Horton 93-95

April 1957 | Vol. 1, No. 2

- Articles

A 32,000-Word Magnetic-Core Memory
by E. D. Foss and R. S. Partridge 102-109

Computation of e^N for $-\infty < N < +\infty$ Using an Electronic Computer
by E. G. Kogbetliantz 110-115

The Multipurpose Bias Device—Part I: The Commutator Transistor
by B. Dunham 116-129

Addressing for Random-Access Storage
by W. W. Peterson 130-146

The Lorenz Number
by P. J. Price 147-157

A Positive-Integer Arithmetic for Data Processing
by R. W. Murphy 158-170

Irredundant Disjunctive and Conjunctive Forms of a Boolean Function
by M. J. Ghazala (Gazale) 171-176

A Mathematical Model for Determining the Probabilities of Undetected Errors in Magnetic Tape Systems
by M. Schatzoff and W. B. Harding 177-180

- Short Communications

A Self-Clocking System for Information Transfer
by L. D. Seader 181-184

A Symmetrical-Transistor Steering Circuit
by J. L. Walsh 185-188

Determination of Transient Response of a Drift Transistor Using the Diffusion Equation
by H. B. von Horn and W. Y. Stevens 189-191

July 1957 | Vol. 1, No. 3

• Articles

Development of the Permissive-Make Relay
by B. J. Greenblott and J. E. Wallace 198-211

Two-Collector Transistor for Binary Full Addition
by R. F. Rutz 212-222

Spatial Variation of Currents and Fields Due to Localized Scatterers in Metallic Conduction
by R. Landauer 223-231

Microwave Amplification by MASER Techniques
by W. V. Smith 232-238

The Linear Hall Effect
by P. J. Price 239-248

Literary Data Processing
by P. Tasman 249-256

An Experimental 50-Megacycle Arithmetic Unit
by R. M. Walker, D. E. Rosenheim, P. A. Lewis and A. G. Anderson 257-278

Microsectioning: A Metallographic Technique for Semiconductor Devices
by J. S. Hanson 279-288

October 1957 | Vol. 1, No. 4

• Articles

Trapped-Flux Superconducting Memory
by J. W. Crowe 294-303

An Analysis of the Operation of a Persistent-Supercurrent Memory Cell
by R. L. Garwin 304-308

A Statistical Approach to Mechanized Encoding and Searching of Literary Information
by H. P. Luhn 309-317

The Effect of an Electric Field on the Transitions of Barium Titanate
by M. E. Drougard and E. J. Huibregtse 318-329

A Mechanical Heart-Lung Apparatus
by R. Taylor 330-340

The Formalization of Scientific Languages—Part I: The Work of Woodger and Hull
by B. Dunham 341-348

A Radiant-Energy Heater Using an Ellipsoidal Reflector
by E. H. Nicollian, G. R. Gunther-Mohr, and L. R. Weisberg 349-355

A Binary-Weighted Current Decoder
by E. J. Smura 356-362

Radio-Interference Control as Applied to Business Machines
by J. M. Sarley and R. J. Hendery 363-372

• Short Communications

Superconducting Connections to Films
by J. A. Kurtz 373

Author Index

A

Anderson, A. G.
see under Walker, R. M. . . . . (257)
Astrahan, M. M., B. Housman, J. F. Jacobs, R. P. Mayer and W. H. Thomas
Logical design of the digital computer for the SAGE system 76

C

Cameron, D. P.
Domain orientation in barium titanate single crystals 2
Chambers, F.
see under Cole, H. F. . . . . (90)
Cole, H. F., F. Chambers and H. Dunn
Lattice parameter of Zn_3As_2 90
Crowe, J. W.
Trapped-flux superconduction memory 294

D

Dickinson, W. E.
see under Noyes, T. . . . . (72)
Drougard, M. E. and E. J. Huibregtse
Effect of an electric field on the transitions of barium titanate 318
Dunham, B.
Formalization of scientific languages — Part I: Work of Woodger and Hull 341
Multipurpose bias device — Part I: Commutator transistor 116
Dunn, H.
see under Cole, H. F. . . . . (90)

F

Fitch, C. J.
Development of the electrostatic clutch 49
Foss, E. D. and R. S. Partridge
32,000-word magnetic-core memory 102

G

Garwin, R. L.
Analysis of the operation of a persistent-supercurrent memory cell 304
Gazale, M. J.
see under Ghazala, M. J. . . . . (171)
Ghazala, M. J.
Irredundant disjunctive and conjunctive forms of a Boolean function 171
Greanias, E. C., C. J. Hoppel, M. Kloomok and J. S. Osborne
Design of logic for recognition of printed characters by simulation 8
Greenblott, B. J. and J. E. Wallace
Development of the permissive-make relay 198
Gunther-Mohr, G. R. and S. Triebwasser
Simple constant-temperature oven and control system 84
see also under Nicollian, E. H. . . . . (349)

H

Haanstra, J. W.
see under Lesser, M. L. . . . . (62)
Harding, W. B.
see under Schatzoff, M. . . . . (177)
Hanson, J. S.
Microsectioning: A metallographic technique for semiconductor devices 279
Hendery, R. J.
see under Sarley, J. M. . . . . (363)
Hoppel, C. J.
see under Greanias, E. C. . . . . (8)
Horton, J. W.
General theory of multiple spin echoes 93
Housman, B.
see under Astrahan, M. M. . . . . (76)
Huibregtse, E. J.
see under Drougard, M. E. . . . . (318)

I

Ittner, W. B., III and P. J. Magill
Survey of contact resistance theory for nominally clean surfaces 44

J

Jacobs, J. F.
see under Astrahan, M. M. . . . . (76)

K

Kloomok, M.
see under Greanias, E. C. . . . . (8)
Kogbetliantz, E. G.
Computation of e^N for $-\infty < N < +\infty$ using an electronic computer 110
Kurtz, J. A.
Superconduction connections to films 373

L

Landauer, R.
Spatial variation of currents and fields due to localized scatterers in metallic conduction 223
Lesser, M. L. and J. W. Haanstra
Random-access memory accounting machine — I: System organization of the IBM 305 62
Lewis, P. A.
see under Walker, R. M. . . . . (257)
Luhn, H. P.
Statistical approach to mechanized encoding and searching of literary information 309

M

Magill, P. J.
see under Ittner, W. B., III . . . . . (44)
Mayer, R. P.
see under Astrahan, M. M. . . . . (76)
Murphy, R. W.
Positive-integer arithmetic for data processing . . 158

N

Nicollian, E. H., G. R. Gunther-Mohr and L. R. Weisberg
Radiant-energy heater using an ellipsoidal reflector 349
Noyes, T. and W. E. Dickinson
Random-access memory accounting machine — II: Magnetic-disk, random-access memory 72

O

Osborne, J. S.
see under Greanias, E. C. . . . . (8)

P

Partridge, R. S.
see under Foss, E. D. . . . . (102)
Peterson, W. W.
Addressing for random-access storage 130
Price, P. J.
Linear Hall effect 239
Lorenz number 147

R

Redfield, A. G.
Theory of relaxation processes 19
Rosenheim, D. E.
see under Walker, R. M. . . . . (257)
Rutz, R. F.
Two-collector transistor for binary addition . . . 212

S

Sarley, J. M. and R. J. Hendery
Radio-interference control as applied to business machines 363
Schatzoff, M. and W. B. Harding
Mathematical model for determining the probability of undetected errors in magnetic tape systems 177
Seader, L. D.
Self-clocking system for information transfer . . 181
Smith, W. V.
Microwave amplification by MASER techniques . 232
Smura, E. J.
Binary-weighted current decoder 356
Stevens, W. Y.
see under von Horn, H. B. . . . . (189)
Swanson, J. A.
Clarification of first-order semiconduction effects through use of electrochemical potentials 39

T

Tasman, P.
Literary data processing 249
Taylor, R.
Mechnical heart-lung apparatus 330
Thomas, W. H.
see under Astrahan, M. M. . . . . (76)
Triebwasser, S.
see under Gunther-Mohr, G. R. . . . . (84)

V

Von Horn, H. B. and W. Y. Stevens
Determination of transient responses of a drift transistor using the diffusion equation 189

W

Walker, R. M., D. E. Rosenheim, P. A. Lewis and A. G. Anderson
Experimental 50-megacycle arithmetic unit . . . 257
Wallace, J. E.
see under Greenblott, B. J. . . . . (198)
Walsh, J. L.
Symmetrical-transistor steering circuit 185
Weisberg, L. R.
see under Nicollian, E. H. . . . . (349)
Wyma, E. R.
A three-dimensional printed back panel 32

Z

Zaromb, S.
Analysis of diffusion in semiconductors 57

Subject Index

A

Adders
see Arithmetic *unit (Computer)*
Binary *adders*
Address *systems (Computer)*
Comparison *of random-access systems* 130-46
"Open" *address systems* 133-38, 141-43
— *simulated on IBM 704* 145-46
Amplification, *Microwave*
Maser *techniques analyzed* 233-38
Approximations
e^N *evaluated on computer* 110-15
Arithmetic
Positive *number system for accounting data processing* 158-70
Arithmetic *unit (Computer)*
50-Megacycle *digital unit described* 257-78
Arsenides
see specific compounds, e.g., Zinc *arsenide*

B

Barium *titanate*
Crystal *structure*
Domain *structure visible by etching* 2-7
Phase *transition in electric fields* 318-29
Binary *adders*
Rutz *transistor*
Applied *as bias device* 117-29
Design *and application* 212-22
Blood
Properties *concerned with heart-lung apparatus* 332
Boltzmann *transport equation*
Applied *to linear Hall effect* 239-48
Boolean *algebra*
Functions
Irredundant forms determined 171-76
Business *machines*
Radio *interference control* 363-72

C

Cardiac
see Heart
Cathode-Ray *tubes*
Deflection *yoke driven by digital equipment* . . . 356-62
Character
Recognition *logic tested by simulation* 8-18
— *IBM 650 program* 12-18
Check, *Parity*
Probability *of undetected errors in magnetic tape* 177-80
Circuits
see also Printed *circuits*
no entries this year
Clock *(Computer)*
Millimicrosecond *pulse techniques in 50-megacycle unit* 259-60
Self-clocking *circuit for information transfer* . . 181-84
Clutches
see also Electrostatic *clutches*
no entries this year
Coding, *Numeric*
7-channel magnetic tape code 178
Communication
Statistical *aspects of communicating ideas* 310-13
Commutator *transistors*
see Transistors, *Hook-collector*
Transistors, *Point-contact*
Computers
see also components or routines under
Arithmetic *unit*
Character
Check
Clock
Decoder
Mathematical *logic*
Transistors
see also Digital Computers *and names, e.g.,* IBM 704
Logical *design using transistor multi-purpose bias device* 117-29
Concordances
Punched-Card *compilation* 249-56
Conduction *(Electric)*
Spatial *variation from localized scatterers* 223-31
Constant-Temperature *ovens*
Design *features and operation* 84-89
Contact *resistance*
Measurement *as function of load* 44-48
Contacts
Superconducting *connection to metal film* 373
Crystal *lattices*
see also names of substances, e.g., Zinc *arsenide*
no entries this year
Crystal *structure*
see also as a subdivision under names of substances, e.g., Barium *titanate*
Domain *structure visible by etching* 2-7

Crystals
see also names of substances, e.g., Barium *titanate*
no entries this year

D

Dead *Sea Scrolls*
Indexing *by data-processing machines* 256
Decoder *(Computer)*
Cathode-Ray *tube deflection yoke driven by digital equipment* 356-62
Deflection *yoke*
Driven *by digital equipment* 356-62
Devonshire *free-energy function*
Phase *transition by barium titanate correlated* . . 324-29
Digital Computers
Character *recognition logic* 8-18
IBM 650 *program* 12-18
IBM 305 (RAMAC) *design features and organization* 62-71
IBM 350 (RAMAC) *design features* 72-75
Printed *circuits of IBM 608* 33-38
Sage *system design features* 74-83
Diminish *(Mathematics)*
Use *instead of subtract in data processing accounting* 158-70

E

Echoes *(Physics)*
Theory *for amplitudes and shapes of a series* . . 93-95
Electric *relays*
see Relays
Electric *resistance*
see also Contact *resistance*
no entries this year
Electron *tubes*
see also Transistors
no entries this year
Electronic *relays*
see Relays
Electrostatic *clutches*
Design 53-56
History, *theory* 49-51
Lubrication 52-53
Resistance *material fabricated* 51-52
Error
see also Check
no entries this year
Exponential *functions*
e^x *evaluated on computer* 110-15
e^x *computation adapted from Briggs method* . . 115

F

Ferroelectric *materials*
see also names of substances, e.g., Barium *titanate*
no entries this year
Fick's *laws*
Applied *to diffusion in semiconductors* 57-61
Flip-Flop
Circuits
Bilateral phase inverter triggers Eccles-Jordan flip-flop 186-88
Flux *(Electric)*
Trapped-Flux *superconducting memory* 295-303
Functions
see also Boolean *algebra*
Exponential *functions*
no entries this year
Furnaces
see Ovens

H

Hall *effect*
Formula *obtained from Boltzmann transport equation* 239-48
In *first-order considerations semiconductor conductivity theory* 40-41
Heart *surgery*
Heart-Lung *function apparatus* 330-40
Heaters, *radiant-energy*
Design *using hemi-ellipsoidal reflector* 349-55
Hull, Clark L.
Analysis *of his attempts to formalize language* . 345-47

I

IBM 305 (RAMAC)
Design *features and organization* 62-71
IBM 350 (RAMAC)
Design *features* 72-75
IBM 608
Printed *circuit package* 32-38
IBM 650
Character *recognition logic tested by simulation* . 12-18
Sage *system magnetic drums* 76
IBM 704
e^x *evaluation use* 113
N-1 *small values calculated in address systems* . 132
"Open" *type address system search time calculated* 133-46

IBM 705
Use *in literary analysis of Summa Theologica* . . 254-56
IBM 728
Tape *units in* Sage *system* 76
IBM 738
Driver *circuits* 103-07
Sense *amplifier* 107-09
Indexing
Punched-Card *compilation* 249-56
Statistical *approach to encoding* 309-17
Information *retrieval*
Punched-Card *compilation of indexes and concordances* 249-56
Statistical *approach to mechanized encoding and selection* 309-17
Integers
see also Positive *integers*
no entries this year
Interference
see also Radio *interference*
no entries this year

J

Johnson Rahbek *clutch*
History, *theory* 49-51

L

Language
Formalization *related to work of Hull and Woodger* 341-48
Literary *data processing*
Punched-Card *compilation of indexes and concordances* 249-56
Statistical *approach to mechanized encoding and selection* 309-17
Literature *searching*
see Information *retrieval*
Logic *(Mathematics)*
see Mathematical *logic*
Lorenz *number*
Theory *applied to semiconductors* 147-57
Lungs
Mechanical *lung design.* 333-38

M

Maser
Broadband, *short-transit-time operation analyzed* 233-38
Mathematical *logic*
Diminish *substituted for subtract in accounting data processing* 158-70
Language *formalization application* 341-48
Memory *(Computer)*
see Storage (Computer)
Metallographic *sectioning*
Microsectioning *of semiconductors* 279-88
Microwave *amplification by simulated emission of radiation*
see Maser

N

Numbers
see also Positive *integers*
no entries this year

O

Office *machines*
see Business *machines*
Onsagers *equations*
Semiconductor *diffusion application* 57-61
Ovens, *Constant-temperature*
Design *features and operation* 84-89
Oxygenator
Design *of heart-lung apparatus* 330-40

P

Partially *ordered sets*
see also Boolean *algebra*
no entries this year
Perturbation *theory*
Discussion 19
Phase *inverter*
Symmetrical-Transistor *steering circuit* 185-88
Phase *transition*
Barium *titanate affected by electric field* 318-29
Philology
see Language
Poisson's *equation*
In *first-order considerations semiconductor conductivity theory* 39-41
Positive *integers*
Use *in accounting data processing* 158-70
Printed *circuits*
3-Dimensional *concept applied to IBM 608* . . . 32-38
Pulmonary
see Lung
Pulse *(Computer)*
see also Clock *(Computer)*
no entries this year
Pulse *(Electronics)*
Echo *amplitude and shape theory* 93-95

Q

Quantum *mechanics*
Relaxation *process theory* 19-31

R

Radio *interference*
Control *in business machines* 363-72
Ramac *system*
see also IBM 305 (RAMAC)
IBM 350 (RAMAC)
Circuit *design of phased clock-pulse generator* . 181-83
Random-Access *memory accounting machine*
see Ramac *system*
Relaxation *process (Mechanics)*
Theory 19-31
Relays
Permissive-*make for business machines* 198-211
Resistance *(Electric)*
see also Contact *resistance*
no entries this year
Rutz *commutator transistor*
Use *as full binary adder* 212-222
Use *as multi-purpose bias device* 117-29

S

Sage *system*
Digital *computer design* 74-83
Saint *Thomas Aquinas*
Summa *Theologica analyzed by data-processing machines* 251-56
Scattering *(Electric)*
Spatial *variation in metallic conduction* 223-31
Semantics
see also Language
no entries this year
Semi-Automatic *ground environment*
see Sage *system*
Semiconductors
First-*order considerations conductivity theory* . . 39-43
Impurity *diffusion* 57-61
Lorenz *number theory applied* 147-57
Microsectioning *technique* 279-88
Space *lattice*
see subdivision Crystal *lattice under names of substances, e.g.,* Zinc *arsenide*
Storage *(Computer)*
Magnetic
IBM 305 (RAMAC) *design features and organization* 62-71
IBM 350 (RAMAC) *design* 72-75
IBM 738 *driver circuits and sense amplifier* . . . 103-09
Persistent-Supercurrent *memory operation analyzed* 304-8
Random-Access
Address systems compared 130-46
IBM 305 (RAMAC) *design features and organization* 62-71
IBM 350 (RAMAC) *design* 72-75
Trapped-Flux *superconducting memory* 295-303
Summa *Theologica*
Literary *analysis using data-processing machines* 251-56
Superconductivity
Persistent-Supercurrent *memory operation analyzed* 304-08
Trapped-Flux *superconducting memory* 295-303
Surgical *instruments and apparatus*
Heart-Lung *apparatus described* 330-40
Switching *circuits*
see also Arithmetic unit *(Computer)*
Computers
Digital computers
no entries this year
Symbolic *logic*
see Mathematical *logic*

T

Temperature *bath*
see Thermal *bath*
Thermal *bath*
In *relaxation process (Mechanics)* 19-31
Titanates
see specific compounds, e.g., Barium *titanate*
Transient *response of drift transistor determined theoretically* 189-91
Transistors
Hook-Collector
Rutz transistor used as multi-purpose bias device 117-29
Use as full binary adder 212-22
Point-Contact
Use as full binary adder 212-22
Transition *probability*
see Perturbation *theory*

W

Wangsness-Bloch *theory (Mechanics)*
Modifications 19-31
Wiedemann-Franz *law*
Lorenz *number theory applied to semiconductors* 147-57
Woodger, *Joseph Henry*
Attempts *to formalize language analyzed* 342-45

Z

Zinc *arsenide*
Crystal *lattice* 90-92
Zone Melting
Hemi-Ellipsoidal *reflector heater design for laboratories* 349-55